SCIENCE

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THE ICE-WALL ON THE BEACH AT HULL, MASSACHUSETTS, JANUARY, 1893.

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THE exceptionally long-continued cold of the early part of January, this year, favored the development of a considerable wall of coast-ice on the long barrier beach connecting the rocky headland of Nantasket with Strawberry Hill and the neighboring drumlin at Point Allerton at the entrance to Boston Harbor. At the same time, the embayed waters of Boston Harbor froze over. I visited the beach at Hull on the 24th of the month, at a time the temperature had risen above the freezing point, and when the sheet-ice had left the shore and was only visible as cakes floating near the horizon.

At Nantasket, from the vicinity of the cafes northward to near Point Allerton, the ice-wall formed a rampart near high-tide mark of triangular cross-section, having an average elevation of about 8 feet and a breadth of base of 20 feet. The seaward slope of this wall was shorter and steeper than the landward, and was also much more irregular, owing to the action of the waves and some melting. The landward slope merged into the sheet of snow back of the beach. The accompanying diagram will make clearer this description.

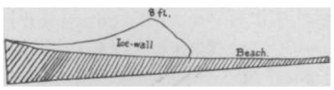

FIG. 1. — General cross-section of the ice-wall at Hull.

The wall was composed in part of cakes, but in larger measure of granular ice, making the whole a compact mass, whose front was broken at frequent intervals by recesses swept by the waves at high tide. The beginnings of these recesses were seen in numerous caverns at the bottom of the ice, some of which were large enough to permit a man to crawl under the arch, and in one case a breach had been made through to the beach in the rear of the wall. In another instance, where the crest of the wall was low, the arch was fissured, as shown in Fig. 2, apparently by the pressure of waves in passing through the tunnel.

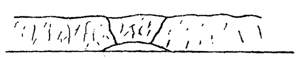

FIG. 2. — Ice-arch fissured by wave-action.

From many of the small caves little streams were trickling out over the sand beach in front. These streams were busily employed at low tide in building and re-arranging small deltas of fine sand, a long stretch of which lay between high and low tide-marks.

The drainage of water produced by the superficial melting of the ice at mid-day was mainly in the form of drops from the protuberant masses one or two feet above the base, which was slightly receding, a feature determined by the water at high tide. These drops of water fell upon the wet sand of the beach and made well-marked pits, the cross-sections of some of which are shown in the adjoined Fig. 3. These pits were distributed along the front of the ice-wall just under the high-tide limit.

Some of these depressions resemble the so-called rain-drop imprints on the older strata, and serve to make us cautious in the interpretation of such markings. I have also seen the spray from surf, as on the beach at Gay Head, Mass., make similar impressions. The larger impressions at Hull were as much as three inches in diameter, but correspondingly shallow, while those which were in process of formation were not over half an inch across and half an inch deep. Around each pit, into which water was dropping, a rim of sand was raised. The larger pits, just described, were, except for what I am about to describe, without any signs of the cause of their formation. In several instances, however, I observed that water was dropping in a narrow, deep pit, formed exactly in the centre of one of the large shallow ones.

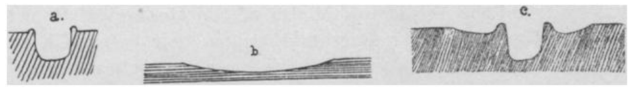

FIG. 3. — Pits made on the beach by water dripping from coast-ice. *a.* Deep and narrow pit. *b.* Broad, shallow pit. *c.* Renovated pit.

The explanation of these pits seems to be this, that, after the dropping has ceased for a time, as by the freezing of the surface of the ice-wall at night, the sands about the deep pits cave in, being highly mobile by reason of the water they contain. If now, on the next period of melting, drops of water drip from the same icicle-like projection of the ice-wall, a new, deep, but narrow pit will form in the place held by the old one. The geological interest of these pits is evident when we compare them with some of the pit-like depressions found in the Cambrian and other deposits of beach origin. The surface of the arenaceous slates of presumably Lower Cambrian age in Somerville, Mass., are marked with pits closely resembling many of these made by water falling from coast-ice. In fact, it would be difficult to distinguish them from the so-called genus of worm-burrows, Monocraterion, where the long tube penetrating the sand is obscure or wanting.

The strength of the waves applied to the face of this wall of ice can be estimated from the fact that a whale, about 40 feet long (*Physeter macrocephalus*), had been washed ashore abreast of Strawberry Hill, and lay with his head to the north, close up to the foot of the wall of ice, apparently in a position determined by the run of the shore-current during a "north-easter." The depth of water necessary to float this body in was in part obtained through the backing-up of the waves against the wall of ice. The effect of this action on the regimen of the beach was better shown on the bouldery pavement near Point Allerton.

Under the ordinary summer conditions of this beach, the swash of the surf advances up it as a thin sheet of foaming water, halts for an instant, and then recedes, to be overtaken by another wave. The ice-wall, however, at high-tide mark, or just below it, interferes with the action of the swash. The result is that the water is held up against the ice-wall, and when it recedes goes out as a deeper sheet than when the wave has a chance to run up the beach and spread out as a thin layer of water. This thin sheet of water cannot move the larger boulders except by removing the finer materials from their bases, but the thick sheet in front of the ice-wall acts more potently on the larger cobbles and boulders, dragging them up and down the beach, so that its aspect is for the time quite altered. To this action must be added the effect of cakes of ice, with inter-stratified layers of sand and gravel and occasionally included cobbles, which are left pell-mell on the beach with the receding tide.

The larger beach pebbles, which have been reduced to the form of wear characteristic of their class, exhibit an interesting fact which should be noticed here. During the season of minimum wave-action, the pebbles are smoothed by attrition with the finer gravels and sands, which are alone in movement; but in the winter, during heavy storms, the pebbles and cobbles are dashed together, and their smooth surfaces scarred with dents. In the case of an elongate cylindrical pebble, it was very apparent from

the grayish pulverulent appearance of the extremities that the wear was greater on the ends than on the sides, though it should be remarked that this pebble was probably thrown sideways quite as frequently, if not more frequently, than endwise against its neighbors.

THE GENERIC EVOLUTION OF THE PALÆOZOIC BRACHIOPODA.

BY AGNES CRANE, BRIGHTON, ENGLAND.

IT is a time-honored saying that "a prophet is not without honor save in his own country," but the name and fame of Professor James Hall, LL.D., director of the State Museum of Natural History of New York, and its veteran State geologist, are well known in Canada and the United States and have long been recognized and appreciated among the geologists and invertebrate palæontologists of Europe. The highest recognition in geological circles was accorded him nearly a quarter of a century ago, when he was awarded the Wollaston Medal of the Geological Society of London, the year after Barrande, and a year before Charles Darwin received it. His arduous life-long researches have resulted in the production of the fine series of monographs of "The Palæontology of New York," of which Vol. VIII., Part I., Brachiopoda,[1] by James Hall, assisted by John M. Clarke, has recently made its appearance, with an unusually interesting text and the well-executed plates for which the series has been remarkable. As a fossil brachiopodist Professor Hall ranks with his eminent contemporaries, the late Dr. Thomas Davidson, F.R.S., and Joachim Barrande of Prague. In one respect he may be said to take higher position as a philosophical investigator, inasmuch that he kept free from prejudice with regard to the theory of evolution as applied to the class Brachiopoda at a time when, owing to the condition of our knowledge of the group, it was not possible to adduce actual proofs of the logical postulate in that direction.

Times and methods have changed indeed since the celebrated Bohemian palæontologist definitely proclaimed that the evidence of the Cephalopoda[2] and of the Brachiopoda[3] was opposed to the truth of the theory of evolution, and Dr. Davidson, in answer to a personal appeal from Darwin, replied that he was unable to detect direct evidence of the passage of one genus into another.[4]

There has been a marked advance in the philosophical treatment of this important group of ancient and persistent organisms during the last decade, and to this progress American scientists have contributed largely. Mr. W. H. Dall has differentiated and described some new genera and species of the recent forms of interest and value. Professors Morse, Brooks, and Beyer, and of late Dr. Beecher and Mr. Clarke, have revealed suggestive phases in the developmental history of typical genera and well-known species. Now Professor James Hall and Mr. J. M. Clarke have sifted and compared the vast accumulations of data recorded by earlier writers by the older methods of descriptive palæontology, and, combining the results thus gained with the best features of the new school of investigators, have effected a revolution in the general treatment of the entire class of Brachiopoda. They trace important stages in the phylogeny of the fossil forms and various links connecting them through their immediate successors with the surviving members of the group.

Much of this work could not possibly have been accomplished had it not been for the mass of descriptions and figures of the vast number of species recorded in the works of Barrande, Davidson, De Koninck, D'Orbigny, Defrance, Deslongchamps, Suess, Lindstrom, Pander, Quenstedt, Geinitz, Littell, Oppel, Oehlert, Waagen, and Neumayr, in Europe, and Billings, Hall, Clarke, Meek, Shumard, Worthen, Walcott, White, Whitfield, and others on the continent of America.

The warm and discriminating recognition of the valued labors of his European fellow-workers is one of the most agreeable features of Professor Hall's new volume. It is pleasant to read "of the greatest of all works on the Brachiopoda by Thomas Davidson," of the just appreciation of Barrande's herculean efforts in the Silurian field, of the excellence of William King's anatomical investigations, to find Pander's early work valued and his names restored. These are just and generous tributes to the memory of comrades who have gone before most welcome in these latter days of that strident "individualism" which is often mere egotism in disguise.

The New York palæontologist's recent work is not only a critical *résumé* with descriptions and figures of the Brachiopoda of New York, but a careful analysis of the results of the labors of his predecessors and contemporaries in the same extended palæozoic field of research in the United States, Canada, Russia, Sweden, and Great Britain. This gives it a cosmopolitan value, and affords opportunity, by means of critical comparisons of genera, species, and varieties from the geological horizons of both hemispheres, to recognize the identity of species, to define synonyms, to collate genera and sub-genera, to indicate their inter-relationships, and to illustrate the passage-forms linking one group, or assemblage of allied genera, to another. To this branch of the subject we must now restrict our observations.

With singular modesty the authors refrain, for the present, from proposing any new scheme of classification. The primary division of the class into two orders comprising the non-articulated and articulated genera is adopted. We fail to see why Owen's names of *Lyopomata*, or "loose valves," and *Arthropomata*, or "jointed valves," should have been discarded, for they define the same limits and distinctions as Huxley's simpler, but later, names, *Articulata* and *Inarticulata*, the first of which was employed by Deshayes to designate certain forms of Brachiopoda before the publication of Huxley's "Introduction to the Classification of Animals." In England it is generally conceded that the priority and scope of Owen's orders were clearly established by the American systematist, Dr. Theodore Gill. The matter, however, is of less moment now that a general tendency to admit greater ordinal sub-division has arisen. Waagen has proposed six orders, Neumayr eight, and Beecher four, based on the peduncular opening and associated characters.

The names *Inarticulata* and *Articulata* express certain general distinctions. Nevertheless, it is a matter of fact that forms have often appeared which cannot be separated thus, for tendencies to transgress these artificial limits become apparent in various directions. For instance, the species of the Silurian genus *Trimerella* was shown by Davidson and King to be but feebly articulated, and now *Neobolus*, *Spondylobolus*, and Hall's new linguloid genus, *Barroisella*, are shown to exhibit the same propensity. We are glad to note that, although fifteen years have elapsed since the publication of the Memoir on the *Trimerellidæ*, by Thomas Davidson and William King,[5] it is frankly admitted that later observations have hitherto added comparatively little to the results achieved by those eminent investigators and have taken away nothing from their value.

In the present publication the semi-artificial, but convenient, family designations are not adopted, but the genera discussed fall into groups of associated genera, often exhibiting intermediate characters, which link one genus naturally with another. More has been accomplished in this direction than could possibly have been anticipated, and the eighth volume of the Geological Survey of the State of New York (Palæontology) would have made glad the heart of Darwin, for its dominant note is the evolution of genera.

Hitherto *Lingula* has always been regarded as taxonomically at the base of the Brachiopoda in spite of the acknowledged complexity of its muscular system and the date of its appearance in the geological series. It is now shown conclusively to be developed from an obolelloid type which culminated in a faunal epoch anterior to the appearance of *Lingula*, and Brook's history of the development of the living species is cited as confirmatory proof

[1] Natural History of New York. Palæontology, vol. viii. (Geological Survey of the State of New York), "An Introduction to the Study of the Genera of Palæozoic Brachiopoda." Part. I. By James Hall, State Geologist and Palæontologist, assisted by John M. Clarke. Albany, 1892.

[2] Cephalopodes, Etudes Générales par Joachim Barrande, Prague, 1877, p. 224.

[3] Brachiopodes, Etudes Locales, *Ibid*, 1879, p. 206.

[4] "What is a Brachiopod?" by Thomas Davidson, F.R.S., Geological Magazine, Decade II., vol. iv., 1877.

[5] Quarterly Journal of the Geological Society of London, vol. xxx., p. 124, 1874.